Pacific Coast Oil Spill Concept

for

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prepared by

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FOREWORD

This document is part of a overall presentation package which is supported by a scoping document and literature assessment (see References). The concept described here is part of a Federal Government initiative to improve spill response capabilities on Canada's West Coast.

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The Pacific Coast Oil Spill concept is presented here for open discussion and comments. The concept is not an approved project, and will only be implemented following a broad concensus from interested groups (government, industry, and concerned citizens).

CONTENTS

SUMMARY

The following presentation describes a project which will improve the ability of government, industry, and concerned citizens to cleanup a large oil spill on the West Coast.

There is a serious lack of information regarding the best means of cleaning oiled shorelines. Informed decisions about the best approach to cleaning up a spill in different circumstances require knowledge about the relative effectiveness and environmental impact of different techniques; this knowledge is not available from existing literature or from the *Exxon Valdez* experience.

This project proposes the deliberate spillage of small volumes of oil in a carefully controlled manner on shore or immediately offshore such that the oil strands naturally. A variety of cleanup techniques will be applied to the oil and the results measured (both cleanup effectiveness and biological recovery). A carefully designed long term measurement program will provide a unique appraisal of both the advantages and drawbacks of different oil cleanup techniques.

There are significant benefits in being able to experiment with real oil in a natural setting, benefits which cannot be gained in either a laboratory or emergency situation. This project will provide an entirely new knowledge base about the relative recovery rates of West Coast ecosystems when different cleanup methods are used.

The long-term environmental impacts of this project will be limited to localized disturbances over very short sections of the coast (in the order of a few hundreds of meters). There will be no measurable impacts on the regional populations of any species (fisheries, marine mammals, birds, or benthic communities). In contrast, the long-term benefits from this project will include more effective spill cleanups and reduced environmental damage in the future.

INTRODUCTION AND PROJECT BACKGROUND

The Pacific Coast Oil Spill (PCOS) concept was initiated in 1988 by Environment Canada to review existing deficiencies in oil spill cleanup and disposal techniques, and to make recommendations for possible field research to improve the capabilities of government and industry in responding to oil spills off the West Coast of both Canada and the United States.

Shortly after starting the initial review, oil from the Nestucca oil spill off Grays Harbour, Washington impacted the west coast of Vancouver Island. This incident was followed in March, 1989 by the *Exxon Valdez* disaster which dramatically exposed serious deficiencies in the application of existing cleanup techniques to a catastrophic spill.

The *Valdez* and *Nestucca* experiences with their extensive media coverage, graphically brought home the need for new oil spill research initiatives on the West Coast. These events led to a series of internal, inter-governmental, and public discussions, reviews, and reports on tanker safety and marine spill response

In February 1990, a scoping document and preliminary experimental plan was produced (Dickins, 1990); this work identified a series of possible field programs which would address many of the deficiencies identified during the ongoing reviews.

A decision was made early in 1990 to focus on shoreline cleanup as the most pressing area of concern where existing techniques appeared either inadequate or unproven in terms of their actual effectiveness and environmental impacts.

A second project phase was initiated to further assess the state of knowledge on shoreline cleanup before proceeding with any more detailed experimental plans. The aim of this assessment was to:

> **first,** determine whether the deficiencies identified in the scoping document could be addressed by more effectively utilizing historical information;
>
> **second,** to select which shoreline cleanup techniques were most suitable for testing; and
>
> **third,** to critically re-examine the need for and importance of experimental oil spills.

The purpose of this document is to describe why such spills are necessary to advance the state of spill response preparedness on the West Coast.

PROJECT DESCRIPTION

Objectives

The Pacific Coast Oil Spill (PCOS) concept encompasses a series of field experiments in which different oil types are deposited in a controlled manner on the shore between the low and high tide lines.

There are two principal objectives to carrying out the project:

1. To evaluate proven or promising shoreline cleanup techniques in terms of their environmental effects and recovery of impacted biota.

2. To quantify and assess the effectiveness of different cleanup techniques applied to both crude and bunker oil deposited on course sediment shorelines (mixture of sand, gravel, pebbles, and cobble).

The purpose of the this study is to provide high quality scientific evidence which will enable response personnel to make informed decisions as to the correct choice of cleanup technique, i.e., one which maximizes the rate of cleanup while minimizing the environmental damage associated with the cleaning technique itself.

Important Benefits: The field spills will provide an ideal training opportunity for spill response crews, Coast Guard personnel, regulators, and local community groups.

This project will lead to a standard reference document to guide response crews in selecting environmentally acceptable cleanup techniques of known effectiveness. In the opinion of local government specialists involved with the *Nestucca* spill on Vancouver Island, the cleanup operations would have benefited immensely from a manual or standard reference document which (a) clearly described the various cleanup options, (b) outlined their

effectiveness under different conditions, and (c) outlined their associated effects on the environment.

The literature assessment conducted as part of this study shows that the information needed to compile such a cleanup guide for West Coast shorelines does not exist at present and will not be available from the Valdez research programs (due to a lack of baseline studies and inadequate documentation of the cleanup procedures). This is not intended as a criticism of the scientific programs associated with the Valdez monitoring, but rather as a limitation associated with all accidental spills.

The results of the literature assessment showed clearly that there are serious knowledge gaps which prevent a complete understanding of the relative effects, and effectiveness of different shoreline cleanup techniques. The literature assessment is available as a supporting document to the project (see References).

The field experiments will also provide an opportunity to test a variety of oil disposal options.

Project Status: The project has proceeded through general scoping and conceptual design, literature assessment, and preparation of a project description for initial public consultation (the current point in the program).

Public opinions and concerns as well as critical scientific reviews will be sought and welcomed at any time as the project develops through the following phases: site selection, permit application, detailed experimental design, costing, and baseline studies.

The earliest that the first small scale experimental spills could take place is during the late summer or fall of 1992.

Technical Concept

Site Selection: At this stage in the project, there has been no selection of experimental sites. A detailed evaluation of all potential locations will be conducted (suggestions for candidate sites are welcomed).

The ideal site will be readily accessible, with a variety of representative shoreline types, and nearby accommodation and support facilities. The project team will reject all sites where direct impacts on important recreational, biological, cultural resources, or native subsistence harvesting are a possibility. The input of native groups, and other local residents will be actively solicited before making any decisions as to the final choice of recommended sites.

It may be possible to utilize sites with a previous history of environmental disturbance or industrial pollution. Care must be taken to ensure that any existing site contamination will not invalidate any results from the field experiments (particularly in terms of relative long-term impacts).

The project team has made a decision to focus on course sediment sandy gravel, pebble and cobble beaches which dominate much of the B.C. coast. These combinations of substrate type are considered the most difficult types of shoreline to clean (in contrast to sand beaches and exposed rocky outcrop).

Baseline Studies: Prior to spilling any oil, the selected location will be subjected to baseline studies to characterize the ecology, geomorphology (beach substrate description), and levels of background contaminants. This baseline data which is essential to interpreting the final results in terms of biological recovery, and long-term environmental effects is usually missing from studies of accidental spills (the *Exxon Valdez* being a prime example).

Contingency Plans: A detailed contingency plan would be developed as part of the experimental design to ensure that the oil is controlled under worst case conditions, and that the potential for associated impacts is minimized.

This plan will include skimmers and booms with sufficient capacity to deal with any oil discharged into the water. For example, it may prove necessary to maintain sorbent booms to guard against the presence of oil sheens nearshore. Bird scaring devices, and wildlife monitors would be used to ensure that animals are kept away from the oiled areas.

The contingency plan will incorporate education, monitoring, and protection sections to ensure that any cultural resources in the immediate vicinity of the test plots are protected during all phases of the project. Native band members will be involved in the development of an educational program to identify important cultural resources, and to instruct project personnel as to their sensitivity.

Number and Size of Spills: Bunker fuel and/or Prudhoe Bay crude oil would be released upon, or to impinge upon, selected course sediment shorelines. The number of individual oil releases would depend on the number of experiments (combinations of different cleanup techniques, shoreline types, wave exposures, and oil types). The size of each spill would depend on the spill scenario, the desired oil loading, the porosity of the sediment, the intertidal width, and the length of shoreline required for a meaningful test.

Although very small plots minimize the environmental impact, they are unsuitable for determining the long term effects or cleaning rates of techniques such as water flushing. Drawbacks to such plots include the natural dispersion of oiled sediments from the plots (confusing attempts to monitor the technique itself), edge effects (confusing measurements of biological recovery), and insufficient area to support statistical sampling.

For many studies, a meaningful assessment of a cleanup technique requires that a continuous section of the coast (in the order of 100 to 300 m in length) be uniformly oiled and monitored.

Previous experiences with the most suitable techniques suggest the use of a minimum of three areas of continuous oiling for the evaluation of different treatments, and one additional area as a control (natural cleaning).

Controls: Control beaches established prior to discharge with similar environments to the test areas would be monitored to check the ecosystem recovery rates observed in oiled areas against natural rates. The option also exists to create an oiled control where no cleanup takes place; this would be an extremely valuable addition to the experiment in that the results would clearly show the benefits of active intervention relative to natural cleaning processes.

Choice of Experiments: The final schedule of shoreline experiments will be decided though a matrix approach which looks at all of the possible combinations of oil type, technique, sediment size/composition, beach permeability, and wave exposure. A preliminary assessment of shoreline cleanup techniques has been made by using a matrix to look at variables such as beach type and oil type. The final selection of techniques will reflect the opinions of experts in the field and the conditions at the site.

Potentially effective and practical techniques identified in the preliminary assessment are described below:

> **Remove, Clean, and Replace:** this generic technique involves the physical removal of the oiled substrate (pebbles, boulders, cobble, gravel), cleaning of the substrate (e.g., by incineration, or washing), and replacement of the cleaned material back onto the beach. The process of removal and replacement can be accomplished by manual or mechanical methods depending on the shoreline conditions.
>
> **Reworking and/or Relocation:** this technique involves removing oiled beach material from the upper tidal zone and relocating it to the more active surf zone lower down the beach to take advantage of the natural cleaning and dispersion through wave energy. The practical

use of this technique is limited to those shorelines with at least a moderate degree of exposure to surf.

In Situ Water Flushing: this category includes different combinations of temperatures and pressures (similar to procedures used in Prince William Sound during the first summer).

Other Techniques: This includes methods which may prove effective under specific conditions. Examples are:

- Vacuum suction of thick oil pools
- Bioremediation through the application of fertilizers
- In situ burning of fresh oil on the beach with driftwood
- Chemical spill treating agents

It is proposed to conduct experiments with two different oil types most likely to be involved in future West Coast spills, heavy fuel oil (commonly referred to as Bunker) from barges or deep-sea vessels, and spills of Alaska North Slope crude oil from dedicated tankers in the Valdez trade. In order to make the project as realistic as possible, selected experiments will use both emulsified and fresh oil for comparison purposes.

The coastal category referred to as mixed sediment beach (after Owens, 1981) was chosen in this project as the shoreline type which presents difficulties for effective oil removal, and also constitutes a significant proportion of British Columbia's coast (the second most prevalent type after cliffs). A mixed sediment beach is normally comprised of a poorly sorted mix of boulder, cobble, pebble, granule, and sand. Beach widths are generally less than 30 m with a steep gradient (after Harper, 1981; Owens, 1981).

Another beach type of concern involves a pebble/cobble mix with a high porosity (probability of significant oil penetration).

Data Collection: A rigorous data collection program will be designed with inputs from a number of experienced scientists having experience with previous experimental and accidental spills. The program will focus on the primary objectives of the project to measure the effectiveness of cleanup in terms of ecosystem recovery rates. This will involve detailed studies of the fate and effects of the oil over time together with the health of the local biological communities.

The amount of oil removed from the shoreline would be measured in relation to the amount released. Physical and chemical properties of the oil would be measured as a function of time. The physical disturbances associated with different cleanup methods would be documented along with the natural recovery rates in terms of shoreline reworking with storms and tides.

Rationale - Why Spill Oil Deliberately?

Any suggestion of deliberately spilling oil into the environment immediately raises the questions such as "Why is this necessary" and "Why can't we gain the necessary information in some other way - wait for another *Valdez*, do some laboratory experiments etc." This section presents the overall rationale for the project, followed by a set of questions and answers which will hopefully address a number of common concerns about the project.

Existing Problems: Experiences in Prince William Sound have revisited many of the lessons learned from other large spills. Shoreline cleanup cannot be viewed in terms of one dominant techniques; a battery of approaches are needed to handle a range of oil properties and physical conditions (oil viscosity, sediment size, porosity, degree of contamination, logistics, and environmental sensitivity). Timing of the application of a technique often proves critical to its success.

Need for Clear Guidelines: Quantitative criteria regarding effects of oil properties, oil weathering, beach type, wave energy, access, biological resources are needed to make the correct cleanup choice. The quantitative scientific results needed to develop these criteria are still not available in spite of a great deal of practical experience in dealing with large spills over the past twenty years.

The wrong technology is often used (or the right one used wrongly) because of a serious lack of knowledge, guidance, and experience. Experimental spills provide the best means of acquiring the quantitative data needed to improve this situation.

Lack of Existing Knowledge: Shoreline cleanup is presently characterized by a general lack of knowledge and a lack of clear consensus. A worldwide literature survey found that no single previous test or spill provides a complete set of information required to make intelligent cleanup decisions in a typical West Coast environment. Results from different spills and tests

cannot be combined due to differences in oiling, beach type, wave energy, and other parameters.

Lack of Forthcoming Knowledge from Accidental Spills: Large accidental spills such as the *Exxon Valdez* are characterized by extensive documentation of regional impacts after the spill (usually with no pre-spill reference points), minimal hard evidence of technological effectiveness, and a lack of data relating biological recovery to a particular cleanup technique.

Accidental oil spills are by their emergency crisis nature not usually suitable for controlled scientific information gathering:

- important information prior to the spill and during the initial stages or cleanup is often missing or inconsistent
- over-extended resources needed for cleanup severely limit the ability to conduct regular scientific studies or engineering evaluations
- operational personnel are preoccupied with the crisis; making cooperation difficult
- there is no guarantee that the characteristics an accidental spill will permit important problems to be studied

Cleanup personnel in Prince William Sound identified the lack of information on technology effectiveness as the greatest impediment to developing a rational strategy to guide the long-term cleanup.

Advantages of Experimental Spills: Shoreline experiments can accomplish the following goals which cannot be achieved in either a laboratory setting or in an accidental spill:

- Allow strictly controlled experimental release of oil. In this way the known initial loading of oil forms a reference point against which to rate subsequent cleanup actions and biological impact.
- Fill knowledge gaps which currently restrict the application of effective oil spill cleanup techniques on the West Coast.
- Allow a simultaneous assessment of alternative techniques while the oil is still fresh.
- Measure ecosystem recovery rates against known baseline values.

The record of experimental spills over the past 15 years is one of significant new knowledge gained with negligible environmental impact. Canada has a history of carefully conceived experimental spills, all of which have been carried out with no significant impacts on the environment (e.g., Balaena Bay Oil Spill, 1974/75; McKinley Bay, 1980; Newfoundland Offshore Boom Trials, 1987). The information gained in experimental spills is most applicable to a specific environment (geomorphology, biology, climate). Previous experiments were focussed on the particular problems of arctic oil spills. There has never been an experimental oil spill which was designed to answer specific questions related to the West Coast environment.

Perhaps the most well known example of a successful experimental spill in Canada is the Baffin Island Oilspill Project (BIOS); BIOS successfully accomplished all of its objectives with no long-term environmental impact. This proposed concept draws on the BIOS project experience in a number of different areas (project management, scientific methods, and local involvement - see Sergy and Blackall, 1987).

Questions and Answers

The purpose of this section is to pose a number of representative questions which people may have on the project. Additional material will be prepared in response to other issues as they come up during public discussions.

Why do PCOS when all we have to do is wait for the Prince William Sound *(Exxon Valdez)* results?

1. There was no organized program of technology evaluation associated with the *Valdez* cleanup effort.

2. The ongoing fate and persistence studies in Prince William Sound suffer from a basic weakness in that they lack the necessary scientific starting points of initial oiling, biological productivity, and cleanup documentation. There may be no logical explanation for differences in natural cleaning rates observed between many of the sites deliberately set aside for further study in Alaska due to this lack of pre-spill documentation.

3. The *Valdez* experience relates to crude oil only; the more probable product to be encountered in future medium scale West Coast spills (less than 5,000 bbl) is fuel oil from barges or deep sea vessels.

Why don't we just do the spills in a lab or hydraulic test facility (avoid polluting the environment)?

There are many complex physical processes which affect the fate of oil on a real shoreline; these processes cannot be realistically modelled on a small scale.

There is no known method of successfully constituting sediments in a realistic manner in a lab situation (tendency to lose the fine materials). It is almost impossible to simulate tidal action in the laboratory. There are too many complex processes at work in a real environment to successfully replicate in a basin situation. The duplication of biological recruitment in an artificial laboratory situation difficult if not impossible.

Why not simply go and spill fresh oil on the "set aside" beaches in Prince William Sound?

The beaches set aside for research in Prince William Sound were not selected on a rational logical, scientific basis. The resulting mix of beach types makes direct comparison of cleaning rates very difficult if not impossible - see also the answer to the first question). Once fouled, the set aside beaches are useless for any further assessment work which requires a clean beach to start with. The ongoing litigation process poses a further obstacle to any further research spills in the Prince William Sound area.

How will you ensure that there will be no long-term environmental impact?

1. Small, controlled experimental spills do not result in significant environmental impact (documented references are available to support this conclusion). We will maintain adequate separation (buffer zone) from any biologically sensitive areas (e.g., spawning streams) through careful site selection. Additionally we will monitor bottom sediments, and shellfish in the vicinity fo the spill sites for elevated hydrocarbon levels.

2. We will ensure that adequate measures are in place to control the oil during the spill, and to handle any unforeseen emergencies; a full contingency plan will be developed as in previous spills of this type (e.g., Baffin Island Oil Spill Project, 1981). Oil will only be spilled under optimum environmental conditions (wind direction, sea conditions etc.) to ensure that full control of the experiment is maintained throughout the period of oiling.

3. By maintaining protective sorbent booms across all of the bays for as long as necessary to ensure that any fresh oil leaching off the beach face does not create sheens of danger to bird life.

4. Any oil remaining at depth after termination of the cleanup effort will affect small areas a few hundred meters in extent. The toxicity of the oil to living organisms decreases rapidly after the spill and the remaining oil is expected to cause no problems for the wildlife in the area of the spill sites.

Will you guarantee that all of the sites will be returned to their natural state?

The objective of this project is to evaluate and select the shoreline cleanup techniques which produce the greatest net benefit to the environment, i.e. minimum adverse effects and an enhanced recovery of the plant and animal life. This "recovered" ecosystem may not have the same composition or age structure as that which existed prior to the spill. Ecosystems fluctuate constantly due to natural causes (e.g., unusually cold winter or severe storms). These natural changes can be in the same order as or greater than changes attributed to an oil spill.

Recovery to a "clean" environment is even more difficult to determine. Significant biological recovery can begin in the presence of substantial amounts of visible oil. The term "clean" can be defined as a return to levels of contamination which have no detectable impact on the function of the ecosystem; this has a very different meaning from "clean" interpreted as complete removal of all oil. This project will use the biological definition to determine when cleanup operations will cease.

Will this project be subject to existing environmental protection legislation?

This project will be subject to provisions of the FEARO review process and other applicable legislation. This document and other supporting material will form the submission for permitting and approvals as required by that legislation.

Why don't you concentrate on preventing spills instead of trying to find ways to clean them up?

There are a number of initiatives in Canada and the United States to significantly reduce the frequency of accidental spills on the West Coast. Examples are double-hulled tankers and barges, and a proposal to build a new, safer offshore oil terminal in Juan de Fuca Strait. Regardless of what improvements are made, no transportation system in the world is foolproof. There will always be spills associated with any form of marine commerce. Given this fact, it is necessary to be as prepared as possible for dealing with the inevitable.

Why should Canadian shorelines be oiled in an experiment when most of the oil threat is American, and Americans won't allow similar experiments in their country?

The oil threat is divided between the two countries. In terms of a large catastrophic spill of crude oil (>100,000 bbl) the most likely source is the U.S. flag Alaskan tankers. In terms of the probability of a Bunker fuel oil spill of smaller volume (typically less than 10,000 bbl) the likely source is about equally distributed between vessels visiting Seattle and Vancouver, and between US and Canadian oil barges. It is important to note that that fuel oil spills from barges and dry bulk carriers are seven times more likely to occur than a crude spill from a tanker (Cohen and Aylesworth, 1990). Regardless of the nationality of the source vessel, the reality is that any large spill in the Juan de Fuca Strait/Puget Sound area has the potential of impacting Canadian shorelines; we have to ensure that we have the capability of dealing with such an event when it happens (Dickins et al., 1990). Americans are currently in the planning stages for a series of shoreline experiments in their own country (American Petroleum Institute, 1990).

If the government missed an opportunity to use the Exxon Valdez spill for science, why don't they concentrate their efforts on being ready for the next spill instead of oiling a pristine beach?

There is a plan for responding to spills of opportunity. Unfortunately, the politics of the Valdez situation prevented the Canadians from acting on this scientific plan. Better preparations to for the next accidental spill do not address the real deficiencies of accidental spills in terms of practical, scientific research: the lack of baseline data (because you never know where the spill will occur), the lack of logistics support and cooperation to support scientists early in the spill when the most interesting results are to be gained on cleanup technology assessment, and the lack of any guarantee that the spill will occur on a shoreline which also happens to have a high research priority.

We are more likely to have diesel or bunker spills than crude oil. Why not test these?

PCOS is designed around both heavy fuel oil and crude oil spills. Diesel oil is not part of the experiment because of its short persistence in the environment, and lack of any practical cleanup methods.

***The Norwegians regularly test offshore oil response with real oil. Why* don't we concentrate on a similar program instead of letting oil come ashore.**

There is no doubt that the Norwegians have developed the most capable offshore response systems. In spite of this development, even the best boom and skimmer systems will be effective off Canada's West Coast for less than 30% of the time in the winter and less than 70% of the time in the summer. These effectiveness factors assume that the systems will arrive on site at a remote location in time to do some good. In most vessel accidents, the oil is often so widely dispersed by the time response equipment arrives that very low recovery rates result, regardless of the quality of the equipment. The net result is that no matter what is done to improve offshore response systems, there is a high probability that a large percentage of oil from an offshore spill will come onshore.

Oil spills are so infrequent that we'd be better off just dealing with them when they occur. What difference will this experiment make ten or twenty years from now when there will be new techniques and new personnel to deal with them.

Large catastrophic spills such as the Exxon Valdez are extremely rare (in the contiguous waters of B.C. and Washington State, approximately once every 500 years for an accident involving a spill greater than 100,000 bbl). Unfortunately, much smaller spills in the 1,000 to 10,000 bbl range can also have serious environmental consequences in protected waters; spills in this size range are much more frequent in the order of once every five to ten years.

How long does ecosystem recovery take?

Recovery is a complex process depending on which biological indicators are used as a relative measure, the degree of oil penetration, wave exposure, substrate type etc. Historical spills provide a guide to expected recovery times in different situations. Rocky exposed shorelines normally experience extremely good recovery (in biological terms) within two to five years after a major crude oil spill. Exceptions are sheltered inner-bay areas which are more protected from natural processes and may retain oil for a decade or more (Baker interviewed about the *Valdez* spill in USA Today, Sept 11, 1990).

Will you monitor the site until recovery is complete?

As explained in a previous answer, the definition of "complete recovery" is complicated by natural fluctuations in the health of any ecosystem. One objective of the monitoring program is to determine which techniques are most effective in enhancing the natural recovery rates and by how much. The individual sites will be monitored until the recovery rate has slowed to the point where any further measurements would be indiscernible from background effects. It is impossible to provide an exact time schedule at this stage. Based on previous experience, it is probable that infrequent monitoring will continue for five years or more following the spills.

How does this project benefit local people and how will they be involved?

Local people including native tribal councils, and community organizations will be involved throughout the project planning and design process. Their opinions and concerns will be considered in choosing the experimental sites, developing contingency plans, and developing procedures for measuring the environmental impact of the spills. Local people will be invited to participate in the

project as observers, and as field assistants to help in long term monitoring, and site security.

The results of this project will be widely distributed at the local level to be used as a guide to environmentally sound cleanup practices for future West Coast spills. Such a guide will assist local volunteer groups, communities, and special interest groups in assessing cleanup operations, an in effectively contributing to future cleanups. All of these groups will have opportunities to participate in training sessions associated with the experimental activities.

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